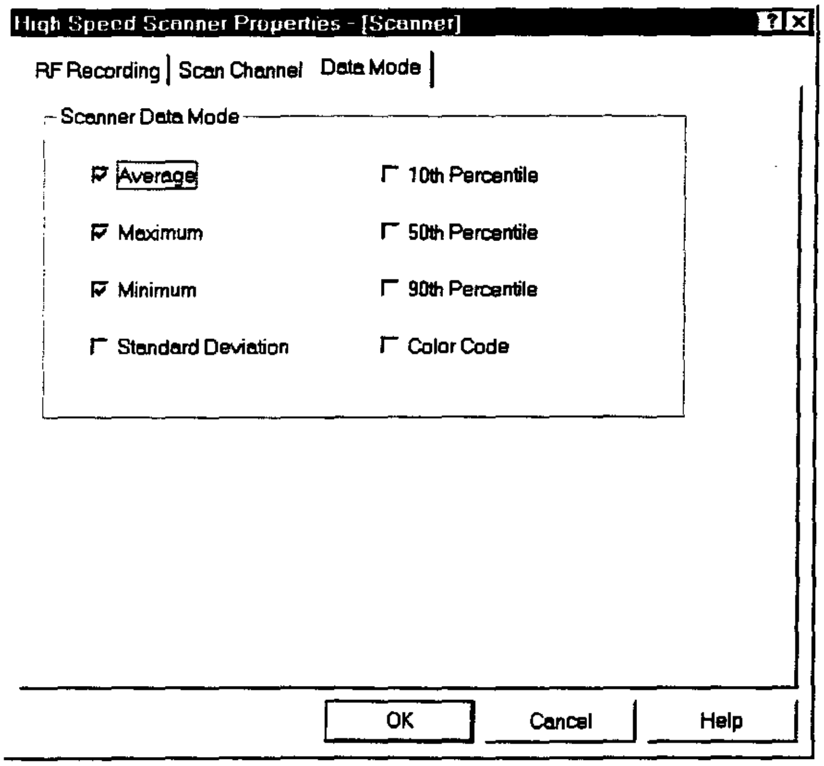
- The final tab for scanner setup is Data Mode (Figure A.8). Average, maximum, and minimum RSSI values are recorded with this option.

Figure A.8 - High Speed Scanner Properties- Tab 3: Data Mode



Appendix B - Tabular Data, BER Impact of AirCell Signal

This Appendix provides tabular data corresponding to the graphical representations in Figure 2.6, and Figure 5.2 through Figure 5.17.

This data represents the calculated impact an AirCell signal will have on the BER of a terrestrial call as a function of the terrestrial call average RSL, *for the duration of a flyby, if the AirCell equipped aircraft has a call up, and it happens to be cochannel with the terrestrial caller.*

These tables thus represent the impact not on *a typical, randomly chosen ground call,* but those calls which satisfy all simultaneous prerequisite conditions for a signal interaction to occur.

16 tables are presented below in Table B.1 through Table B.16, which represent all combinations of Rural, Suburban, Urban, and Dense Urban ground calls with Low or High altitude aircraft, and with Omni or 'Smart Antenna' AirCell serving sites.

Table B.1 BER and AirCell impact, Rural environment, Low Altitude, Omni AirCell server

Average RSL of Terrestrial Call [dBm]	With Cochannel AirCell Presence BER [%]	No Cochannel AirCell Presence BER [%]	Impact of AirCell Presence BER [%]
-76	0.00	0.00	0.00
-77	0.00	0.00	0.00
-78	0.00	0.00	0.00
-79	0.00	0.00	0.00
-80	1.18	1.12	0.06
-81	0.13	0.09	0.04
-82	0.80	0.69	0.10
-83	0.58	0.54	0.04
-84	0.17	0.15	0.02
-85	0.35	0.31	0.04
-86	0.16	0.15	0.02
-87	0.24	0.22	0.02
-88	0.32	0.30	0.03
-89	0.41	0.38	0.03
-90	0.66	0.61	0.05
-91	0.64	0.58	0.07
-92	0.72	0.66	0.06
-93	0.72	0.65	0.07
-94	0.63	0.54	0.08
-95	1.19	1.07	0.12
-96	0.96	0.87	0.10
-97	0.78	0.68	0.10
-98	1.27	1.11	0.16
-99	1.32	1.18	0.14
-100	1.22	1.07	0.15
-101	1.33	1.15	0.18
-102	1.67	1.43	0.23
-103	1.76	1.50	0.26
-104	2.63	2.33	0.31
-105	2.23	1.88	0.35
-106	2.94	2.51	0.43
-107	3.89	3.30	0.59
-108	4.93	4.23	0.69
-109	5.18	4.28	0.89
-110	7.26	6.22	1.04
-111	9.70	8.32	1.38
-112	11.69	10.26	1.42
-113	16.42	14.93	1.49
-114	18.72	16.65	2.07
-115	23.72	21.80	1.92
-116	25.30	23.44	1.86
-117	28.92	26.92	2.00
-118	31.46	29.54	1.92
-119	36.39	34.91	1.48
-120	41.31	40.27	1.04

Table B.2 BER and AirCell impact, Rural environment, High Altitude, Omni AirCell server

Average RSL of Terrestrial Call [dBm]	With Cochannel AirCell Presence BER [%]	No Cochannel AirCell Presence BER [%]	Impact of AirCell Presence BER [%]
-76	0.00	0.00	0.00
-77	0.00	0.00	0.00
-78	0.00	0.00	0.00
-79	0.00	0.00	0.00
-80	1.13	1.12	0.01
-81	0.10	0.09	0.00
-82	0.71	0.69	0.02
-83	0.54	0.54	0.01
-84	0.15	0.15	0.00
-85	0.32	0.31	0.01
-86	0.15	0.15	0.00
-87	0.22	0.22	0.00
-88	0.30	0.30	0.00
-89	0.39	0.38	0.00
-90	0.62	0.61	0.01
-91	0.59	0.58	0.01
-92	0.67	0.66	0.01
-93	0.66	0.65	0.01
-94	0.56	0.54	0.01
-95	1.09	1.07	0.02
-96	0.88	0.87	0.01
-97	0.69	0.68	0.01
-98	1.13	1.11	0.02
-99	1.20	1.18	0.02
-100	1.09	1.07	0.02
-101	1.18	1.15	0.03
-102	1.47	1.43	0.03
-103	1.54	1.50	0.04
-104	2.37	2.33	0.04
-105	1.92	1.88	0.05
-106	2.57	2.51	0.06
-107	3.38	3.30	0.08
-108	4.33	4.23	0.09
-109	4.41	4.28	0.12
-110	6.37	6.22	0.15
-111	8.52	8.32	0.20
-112	10.48	10.26	0.21
-113	15.16	14.93	0.23
-114	16.98	16.65	0.33
-115	22.12	21.80	0.31
-116	23.74	23.44	0.30
-117	27.25	26.92	0.33
-118	29.86	29.54	0.32
-119	35.16	34.91	0.25
-120	40.45	40.27	0.18

Table B.3 BER and AirCell impact, Rural environment, Low Altitude, Smart AirCell server

Average RSL of Terrestrial Call [dBm]	With Cochannel AirCell Presence BER [%]	No Cochannel AirCell Presence BER [%]	Impact of AirCell Presence BER [%]
-76	0.00	0.00	0.00
-77	0.00	0.00	0.00
-78	0.00	0.00	0.00
-79	0.00	0.00	0.00
-80	1.12	1.12	0.00
-81	0.09	0.09	0.00
-82	0.70	0.69	0.00
-83	0.54	0.54	0.00
-84	0.15	0.15	0.00
-85	0.31	0.31	0.00
-86	0.15	0.15	0.00
-87	0.22	0.22	0.00
-88	0.30	0.30	0.00
-89	0.38	0.38	0.00
-90	0.61	0.61	0.00
-91	0.58	0.58	0.00
-92	0.66	0.66	0.00
-93	0.66	0.65	0.00
-94	0.55	0.54	0.00
-95	1.07	1.07	0.00
-96	0.87	0.87	0.00
-97	0.68	0.68	0.00
-98	1.12	1.11	0.01
-99	1.18	1.18	0.00
-100	1.08	1.07	0.01
-101	1.16	1.15	0.01
-102	1.44	1.43	0.01
-103	1.51	1.50	0.01
-104	2.34	2.33	0.01
-105	1.89	1.88	0.01
-106	2.52	2.51	0.01
-107	3.32	3.30	0.02
-108	4.26	4.23	0.02
-109	4.31	4.28	0.03
-110	6.26	6.22	0.04
-111	8.37	8.32	0.05
-112	10.32	10.26	0.06
-113	14.98	14.93	0.05
-114	16.72	16.65	0.07
-115	21.88	21.80	0.07
-116	23.51	23.44	0.07
-117	27.00	26.92	0.08
-118	29.62	29.54	0.08
-119	34.97	34.91	0.06
-120	40.32	40.27	0.05

Table B.4 BER and AirCell impact, Rural environment, High Altitude, Smart AirCell server

Average RSL of Terrestrial Call [dBm]	With Cochannel AirCell Presence BER [%]	No Cochannel AirCell Presence BER [%]	Impact of AirCell Presence BER [%]
-76	0.00	0.00	0.00
-77	0.00	0.00	0.00
-78	0.00	0.00	0.00
-79	0.00	0.00	0.00
-80	1.12	1.12	0.00
-81	0.09	0.09	0.00
-82	0.69	0.69	0.00
-83	0.54	0.54	0.00
-84	0.15	0.15	0.00
-85	0.31	0.31	0.00
-86	0.15	0.15	0.00
-87	0.22	0.22	0.00
-88	0.30	0.30	0.00
-89	0.38	0.38	0.00
-90	0.61	0.61	0.00
-91	0.58	0.58	0.00
-92	0.66	0.66	0.00
-93	0.65	0.65	0.00
-94	0.54	0.54	0.00
-95	1.07	1.07	0.00
-96	0.87	0.87	0.00
-97	0.68	0.68	0.00
-98	1.11	1.11	0.00
-99	1.18	1.18	0.00
-100	1.07	1.07	0.00
-101	1.15	1.15	0.00
-102	1.43	1.43	0.00
-103	1.51	1.50	0.00
-104	2.33	2.33	0.00
-105	1.88	1.88	0.00
-106	2.51	2.51	0.00
-107	3.30	3.30	0.00
-108	4.24	4.23	0.00
-109	4.28	4.28	0.00
-110	6.22	6.22	0.00
-111	8.32	8.32	0.00
-112	10.27	10.26	0.00
-113	14.93	14.93	0.00
-114	16.65	16.65	0.00
-115	21.81	21.80	0.00
-116	23.45	23.44	0.00
-117	26.92	26.92	0.00
-118	29.54	29.54	0.00
-119	34.91	34.91	0.00
-120	40.27	40.27	0.00

Table B.5 BER and AirCell impact, Suburban environment, Low Altitude, Omni AirCell server

Average RSL of Terrestrial Call [dBm]	With Cochannel AirCell Presence BER [%]	No Cochannel AirCell Presence BER [%]	Impact of AirCell Presence BER [%]
-70	0.00	0.00	0.00
-71	0.00	0.00	0.00
-72	0.01	0.01	0.00
-73	0.01	0.01	0.00
-74	0.03	0.03	0.00
-75	0.05	0.05	0.00
-76	0.11	0.11	0.00
-77	0.22	0.22	0.00
-78	0.43	0.43	0.00
-79	0.86	0.86	0.00
-80	1.72	1.72	0.00
-81	0.50	0.47	0.03
-82	1.07	0.98	0.09
-83	0.95	0.93	0.01
-84	0.32	0.30	0.02
-85	0.52	0.50	0.02
-86	0.28	0.27	0.01
-87	0.41	0.39	0.01
-88	0.49	0.48	0.01
-89	0.60	0.59	0.01
-90	0.92	0.89	0.03
-91	0.96	0.92	0.04
-92	1.05	1.02	0.03
-93	1.18	1.15	0.03
-94	1.08	1.04	0.04
-95	1.83	1.77	0.06
-96	1.45	1.39	0.07
-97	1.38	1.33	0.06
-98	2.13	2.05	0.08
-99	2.30	2.22	0.08
-100	2.06	1.97	0.10
-101	2.32	2.19	0.13
-102	2.95	2.79	0.17
-103	3.28	3.10	0.18
-104	4.69	4.49	0.19
-105	4.41	4.16	0.25
-106	5.79	5.47	0.32
-107	7.72	7.28	0.44
-108	9.49	9.02	0.47
-109	10.77	10.18	0.59
-110	14.11	13.49	0.61
-111	17.60	16.91	0.68
-112	19.97	19.21	0.77
-113	24.66	23.89	0.77
-114	28.54	27.58	0.96

Table B.6 BER and AirCell impact, Suburban environment, High Altitude, Omni AirCell server

Average RSL of Terrestrial Call [dBm]	With Cochannel AirCell Presence BER [%]	No Cochannel AirCell Presence BER [%]	Impact of AirCell Presence BER [%]
-70	0.00	0.00	0.00
-71	0.00	0.00	0.00
-72	0.01	0.01	0.00
-73	0.01	0.01	0.00
-74	0.03	0.03	0.00
-75	0.05	0.05	0.00
-76	0.11	0.11	0.00
-77	0.22	0.22	0.00
-78	0.43	0.43	0.00
-79	0.86	0.86	0.00
-80	1.72	1.72	0.00
-81	0.47	0.47	0.00
-82	1.00	0.98	0.02
-83	0.94	0.93	0.00
-84	0.30	0.30	0.00
-85	0.51	0.50	0.00
-86	0.27	0.27	0.00
-87	0.40	0.39	0.00
-88	0.48	0.48	0.00
-89	0.59	0.59	0.00
-90	0.89	0.89	0.01
-91	0.92	0.92	0.01
-92	1.03	1.02	0.00
-93	1.15	1.15	0.00
-94	1.05	1.04	0.01
-95	1.78	1.77	0.01
-96	1.40	1.39	0.01
-97	1.33	1.33	0.01
-98	2.06	2.05	0.01
-99	2.23	2.22	0.01
-100	1.98	1.97	0.02
-101	2.21	2.19	0.02
-102	2.81	2.79	0.03
-103	3.13	3.10	0.03
-104	4.52	4.49	0.03
-105	4.19	4.16	0.03
-106	5.52	5.47	0.04
-107	7.35	7.28	0.07
-108	9.09	9.02	0.07
-109	10.27	10.18	0.09
-110	13.59	13.49	0.09
-111	17.02	16.91	0.11
-112	19.34	19.21	0.13
-113	24.03	23.89	0.15
-114	27.77	27.58	0.18

Table B.7 BER and AirCell impact, Suburban environment, Low Altitude, Smart AirCell server

Average RSL of Terrestrial Call [dBm]	With Cochannel AirCell Presence BER [%]	No Cochannel AirCell Presence BER [%]	Impact of AirCell Presence BER [%]
-70	0.00	0.00	0.00
-71	0.00	0.00	0.00
-72	0.01	0.01	0.00
-73	0.01	0.01	0.00
-74	0.03	0.03	0.00
-75	0.05	0.05	0.00
-76	0.11	0.11	0.00
-77	0.22	0.22	0.00
-78	0.43	0.43	0.00
-79	0.86	0.86	0.00
-80	1.72	1.72	0.00
-81	0.47	0.47	0.01
-82	0.99	0.98	0.01
-83	0.93	0.93	0.01
-84	0.30	0.30	0.00
-85	0.50	0.50	0.00
-86	0.27	0.27	0.00
-87	0.40	0.39	0.00
-88	0.48	0.48	0.00
-89	0.59	0.59	0.00
-90	0.89	0.89	0.00
-91	0.92	0.92	0.00
-92	1.02	1.02	0.00
-93	1.15	1.15	0.00
-94	1.04	1.04	0.00
-95	1.77	1.77	0.00
-96	1.39	1.39	0.01
-97	1.33	1.33	0.00
-98	2.06	2.05	0.01
-99	2.22	2.22	0.00
-100	1.97	1.97	0.01
-101	2.20	2.19	0.01
-102	2.80	2.79	0.01
-103	3.11	3.10	0.01
-104	4.50	4.49	0.01
-105	4.17	4.16	0.01
-106	5.49	5.47	0.02
-107	7.30	7.28	0.03
-108	9.05	9.02	0.02
-109	10.21	10.18	0.03
-110	13.53	13.49	0.03
-111	16.96	16.91	0.04
-112	19.26	19.21	0.06
-113	23.96	23.89	0.07
-114	27.67	27.58	0.09

Table B.8 BER and AirCell impact, Suburban environment, High Altitude, Smart AirCell server

Average RSL of Terrestrial Call [dBm]	With Cochannel AirCell Presence BER [%]	No Cochannel AirCell Presence BER [%]	Impact of AirCell Presence BER [%]
-70	0.00	0.00	0.00
-71	0.00	0.00	0.00
-72	0.01	0.01	0.00
-73	0.01	0.01	0.00
-74	0.03	0.03	0.00
-75	0.05	0.05	0.00
-76	0.11	0.11	0.00
-77	0.22	0.22	0.00
-78	0.43	0.43	0.00
-79	0.86	0.86	0.00
-80	1.72	1.72	0.00
-81	0.47	0.47	0.00
-82	0.98	0.98	0.00
-83	0.93	0.93	0.00
-84	0.30	0.30	0.00
-85	0.50	0.50	0.00
-86	0.27	0.27	0.00
-87	0.40	0.39	0.00
-88	0.48	0.48	0.00
-89	0.59	0.59	0.00
-90	0.89	0.89	0.00
-91	0.92	0.92	0.00
-92	1.02	1.02	0.00
-93	1.15	1.15	0.00
-94	1.04	1.04	0.00
-95	1.77	1.77	0.00
-96	1.39	1.39	0.00
-97	1.33	1.33	0.00
-98	2.05	2.05	0.00
-99	2.22	2.22	0.00
-100	1.97	1.97	0.00
-101	2.19	2.19	0.00
-102	2.79	2.79	0.00
-103	3.10	3.10	0.00
-104	4.50	4.49	0.00
-105	4.16	4.16	0.00
-106	5.47	5.47	0.00
-107	7.28	7.28	0.00
-108	9.02	9.02	0.00
-109	10.18	10.18	0.00
-110	13.50	13.49	0.00
-111	16.91	16.91	0.00
-112	19.21	19.21	0.00
-113	23.89	23.89	0.00
-114	27.58	27.58	0.00

Table B.9 BER and AirCell impact, Urban environment, Low Altitude, Omni AirCell server

Average RSL of Terrestrial Call [dBm]	With Cochannel AirCell Presence BER [%]	No Cochannel AirCell Presence BER [%]	Impact of AirCell Presence BER [%]
-70	0.00	0.00	0.00
-71	0.00	0.00	0.00
-72	0.01	0.01	0.00
-73	0.01	0.01	0.00
-74	0.03	0.03	0.00
-75	0.06	0.06	0.00
-76	0.11	0.11	0.00
-77	0.22	0.22	0.00
-78	0.45	0.45	0.00
-79	0.90	0.90	0.00
-80	1.80	1.80	0.00
-81	2.78	2.78	0.00
-82	1.83	1.82	0.01
-83	1.59	1.58	0.01
-84	1.08	1.08	0.00
-85	1.03	1.02	0.01
-86	0.83	0.83	0.01
-87	0.95	0.94	0.01
-88	1.06	1.05	0.01
-89	1.37	1.36	0.01
-90	2.04	2.02	0.02
-91	2.47	2.45	0.02
-92	2.72	2.69	0.03
-93	3.38	3.35	0.03
-94	3.60	3.56	0.04
-95	4.55	4.51	0.04
-96	4.29	4.24	0.05
-97	5.32	5.24	0.08
-98	6.60	6.51	0.09
-99	7.91	7.80	0.12
-100	8.40	8.25	0.15
-101	10.67	10.48	0.18
-102	13.25	13.05	0.20
-103	15.25	15.02	0.23
-104	18.68	18.49	0.20
-105	21.63	21.44	0.19
-106	25.13	24.96	0.17
-107	29.07	28.92	0.15
-108	32.34	32.23	0.11
-109	36.96	36.86	0.10
-110	39.60	39.51	0.08
-111	44.43	44.39	0.04
-112	46.01	45.97	0.03
-113	43.89	43.85	0.05
-114	48.63	48.62	0.01

Table B.10 BER and AirCell impact, Urban environment, High Altitude, Omni AirCell server

Average RSL of Terrestrial Call [dBm]	With Cochannel AirCell Presence BER [%]	No Cochannel AirCell Presence BER [%]	Impact of AirCell Presence BER [%]
-70	0.00	0.00	0.00
-71	0.00	0.00	0.00
-72	0.01	0.01	0.00
-73	0.01	0.01	0.00
-74	0.03	0.03	0.00
-75	0.06	0.06	0.00
-76	0.11	0.11	0.00
-77	0.22	0.22	0.00
-78	0.45	0.45	0.00
-79	0.90	0.90	0.00
-80	1.80	1.80	0.00
-81	2.78	2.78	0.00
-82	1.82	1.82	0.00
-83	1.58	1.58	0.00
-84	1.08	1.08	0.00
-85	1.02	1.02	0.00
-86	0.83	0.83	0.00
-87	0.94	0.94	0.00
-88	1.05	1.05	0.00
-89	1.36	1.36	0.00
-90	2.02	2.02	0.00
-91	2.45	2.45	0.00
-92	2.69	2.69	0.00
-93	3.35	3.35	0.00
-94	3.56	3.56	0.01
-95	4.51	4.51	0.01
-96	4.25	4.24	0.01
-97	5.25	5.24	0.01
-98	6.52	6.51	0.01
-99	7.82	7.80	0.02
-100	8.28	8.25	0.02
-101	10.51	10.48	0.03
-102	13.08	13.05	0.03
-103	15.06	15.02	0.04
-104	18.52	18.49	0.03
-105	21.47	21.44	0.03
-106	24.99	24.96	0.03
-107	28.94	28.92	0.03
-108	32.25	32.23	0.02
-109	36.88	36.86	0.02
-110	39.53	39.51	0.01
-111	44.39	44.39	0.01
-112	45.98	45.97	0.01
-113	43.85	43.85	0.01
-114	48.62	48.62	0.00

Table B.11 BER and AirCell impact, Urban environment, Low Altitude, Smart AirCell server

Average RSL of Terrestrial Call [dBm]	With Cochannel AirCell Presence BER [%]	No Cochannel AirCell Presence BER [%]	Impact of AirCell Presence BER [%]
-70	0.00	0.00	0.00
-71	0.00	0.00	0.00
-72	0.01	0.01	0.00
-73	0.01	0.01	0.00
-74	0.03	0.03	0.00
-75	0.06	0.06	0.00
-76	0.11	0.11	0.00
-77	0.22	0.22	0.00
-78	0.45	0.45	0.00
-79	0.90	0.90	0.00
-80	1.80	1.80	0.00
-81	2.78	2.78	0.00
-82	1.82	1.82	0.00
-83	1.58	1.58	0.00
-84	1.08	1.08	0.00
-85	1.02	1.02	0.00
-86	0.83	0.83	0.00
-87	0.94	0.94	0.00
-88	1.05	1.05	0.00
-89	1.36	1.36	0.00
-90	2.02	2.02	0.00
-91	2.45	2.45	0.00
-92	2.69	2.69	0.00
-93	3.35	3.35	0.00
-94	3.56	3.56	0.00
-95	4.51	4.51	0.00
-96	4.25	4.24	0.00
-97	5.24	5.24	0.00
-98	6.51	6.51	0.01
-99	7.80	7.80	0.01
-100	8.26	8.25	0.01
-101	10.49	10.48	0.01
-102	13.06	13.05	0.01
-103	15.04	15.02	0.01
-104	18.50	18.49	0.01
-105	21.46	21.44	0.01
-106	24.98	24.96	0.01
-107	28.93	28.92	0.01
-108	32.24	32.23	0.01
-109	36.87	36.86	0.01
-110	39.52	39.51	0.01
-111	44.39	44.39	0.00
-112	45.98	45.97	0.00
-113	43.85	43.85	0.00
-114	48.62	48.62	0.00

Table B.12 BER and AirCell impact, Urban environment, High Altitude, Smart AirCell server

Average RSL of Terrestrial Call [dBm]	With Cochannel AirCell Presence BER [%]	No Cochannel AirCell Presence BER [%]	Impact of AirCell Presence BER [%]
-70	0.00	0.00	0.00
-71	0.00	0.00	0.00
-72	0.01	0.01	0.00
-73	0.01	0.01	0.00
-74	0.03	0.03	0.00
-75	0.06	0.06	0.00
-76	0.11	0.11	0.00
-77	0.22	0.22	0.00
-78	0.45	0.45	0.00
-79	0.90	0.90	0.00
-80	1.80	1.80	0.00
-81	2.78	2.78	0.00
-82	1.82	1.82	0.00
-83	1.58	1.58	0.00
-84	1.08	1.08	0.00
-85	1.02	1.02	0.00
-86	0.83	0.83	0.00
-87	0.94	0.94	0.00
-88	1.05	1.05	0.00
-89	1.36	1.36	0.00
-90	2.02	2.02	0.00
-91	2.45	2.45	0.00
-92	2.69	2.69	0.00
-93	3.35	3.35	0.00
-94	3.56	3.56	0.00
-95	4.51	4.51	0.00
-96	4.24	4.24	0.00
-97	5.24	5.24	0.00
-98	6.51	6.51	0.00
-99	7.80	7.80	0.00
-100	8.25	8.25	0.00
-101	10.48	10.48	0.00
-102	13.05	13.05	0.00
-103	15.02	15.02	0.00
-104	18.49	18.49	0.00
-105	21.44	21.44	0.00
-106	24.96	24.96	0.00
-107	28.92	28.92	0.00
-108	32.23	32.23	0.00
-109	36.86	36.86	0.00
-110	39.51	39.51	0.00
-111	44.39	44.39	0.00
-112	45.97	45.97	0.00
-113	43.85	43.85	0.00
-114	48.62	48.62	0.00

Table B.13 BER and AirCell impact, Dense Urban environment, Low Altitude, Omni AirCell server

Average RSL of Terrestrial Call [dBm]	With Cochannel AirCell Presence BER [%]	No Cochannel AirCell Presence BER [%]	Impact of AirCell Presence BER [%]
-70	0.00	0.00	0.00
-71	0.01	0.01	0.00
-72	0.01	0.01	0.00
-73	0.02	0.02	0.00
-74	0.04	0.04	0.00
-75	0.08	0.08	0.00
-76	0.16	0.16	0.00
-77	0.32	0.32	0.00
-78	0.65	0.65	0.00
-79	1.30	1.30	0.00
-80	2.59	2.59	0.00
-81	3.63	3.63	0.02
-82	2.92	2.88	0.03
-83	2.42	2.40	0.02
-84	1.67	1.67	0.00
-85	1.79	1.77	0.02
-86	1.60	1.59	0.02
-87	1.84	1.82	0.02
-88	2.32	2.29	0.02
-89	3.46	3.41	0.04
-90	4.75	4.70	0.05
-91	5.54	5.47	0.06
-92	7.99	7.89	0.10
-93	9.18	9.08	0.09
-94	10.27	10.15	0.12
-95	12.05	11.93	0.13
-96	14.53	14.35	0.18
-97	17.88	17.63	0.25
-98	19.95	19.67	0.28
-99	23.13	22.79	0.34
-100	26.00	25.58	0.42
-101	29.73	29.15	0.58
-102	32.32	31.71	0.61
-103	35.59	34.89	0.70
-104	37.81	37.18	0.63
-105	41.86	41.26	0.60
-106	44.61	44.18	0.42
-107	46.11	45.77	0.34
-108	47.45	47.30	0.14
-109	49.67	49.64	0.03
-110	49.58	49.54	0.04
-111	49.60	49.57	0.03
-112	49.76	49.73	0.03
-113	50.00	50.00	0.00
-114	50.00	50.00	0.00

Table B.14 BER and AirCell impact, Dense Urban environment, High Alt., Omni AirCell server

Average RSL of Terrestrial Call [dBm]	With Cochannel AirCell Presence BER [%]	No Cochannel AirCell Presence BER [%]	Impact of AirCell Presence BER [%]
-70	0.00	0.00	0.00
-71	0.01	0.01	0.00
-72	0.01	0.01	0.00
-73	0.02	0.02	0.00
-74	0.04	0.04	0.00
-75	0.08	0.08	0.00
-76	0.16	0.16	0.00
-77	0.32	0.32	0.00
-78	0.65	0.65	0.00
-79	1.30	1.30	0.00
-80	2.59	2.59	0.00
-81	3.63	3.63	0.00
-82	2.89	2.88	0.00
-83	2.40	2.40	0.00
-84	1.67	1.67	0.00
-85	1.77	1.77	0.00
-86	1.59	1.59	0.00
-87	1.83	1.82	0.00
-88	2.30	2.29	0.00
-89	3.42	3.41	0.01
-90	4.70	4.70	0.01
-91	5.48	5.47	0.01
-92	7.91	7.89	0.02
-93	9.10	9.08	0.02
-94	10.17	10.15	0.02
-95	11.95	11.93	0.02
-96	14.38	14.35	0.03
-97	17.67	17.63	0.04
-98	19.72	19.67	0.05
-99	22.85	22.79	0.06
-100	25.65	25.58	0.07
-101	29.25	29.15	0.10
-102	31.81	31.71	0.10
-103	35.01	34.89	0.12
-104	37.30	37.18	0.12
-105	41.37	41.26	0.12
-106	44.26	44.18	0.08
-107	45.84	45.77	0.07
-108	47.33	47.30	0.03
-109	49.65	49.64	0.01
-110	49.55	49.54	0.01
-111	49.58	49.57	0.01
-112	49.74	49.73	0.01
-113	50.00	50.00	0.00
-114	50.00	50.00	0.00

Table B.15 BER and AirCell impact, Dense Urban environment, Low Alt, Smart AirCell server

Average RSL of Terrestrial Call [dBm]	With Cochannel AirCell Presence BER [%]	No Cochannel AirCell Presence BER [%]	Impact of AirCell Presence BER [%]
-70	0.00	0.00	0.00
-71	0.01	0.01	0.00
-72	0.01	0.01	0.00
-73	0.02	0.02	0.00
-74	0.04	0.04	0.00
-75	0.08	0.08	0.00
-76	0.16	0.16	0.00
-77	0.32	0.32	0.00
-78	0.65	0.65	0.00
-79	1.30	1.30	0.00
-80	2.59	2.59	0.00
-81	3.63	3.63	0.00
-82	2.88	2.88	0.00
-83	2.40	2.40	0.00
-84	1.67	1.67	0.00
-85	1.77	1.77	0.00
-86	1.59	1.59	0.00
-87	1.82	1.82	0.00
-88	2.30	2.29	0.00
-89	3.42	3.41	0.00
-90	4.70	4.70	0.00
-91	5.48	5.47	0.00
-92	7.90	7.89	0.00
-93	9.09	9.08	0.00
-94	10.15	10.15	0.01
-95	11.93	11.93	0.01
-96	14.36	14.35	0.01
-97	17.64	17.63	0.01
-98	19.69	19.67	0.01
-99	22.80	22.79	0.02
-100	25.60	25.58	0.02
-101	29.18	29.15	0.03
-102	31.73	31.71	0.03
-103	34.93	34.89	0.04
-104	37.23	37.18	0.04
-105	41.30	41.26	0.05
-106	44.22	44.18	0.03
-107	45.80	45.77	0.03
-108	47.32	47.30	0.01
-109	49.64	49.64	0.00
-110	49.54	49.54	0.00
-111	49.57	49.57	0.00
-112	49.73	49.73	0.00
-113	50.00	50.00	0.00
-114	50.00	50.00	0.00

Table B.16 BER and AirCell impact, Dense Urban environment, High Alt, Smart AirCell server

Average RSL of Terrestrial Call [dBm]	With Cochannel AirCell Presence BER [%]	No Cochannel AirCell Presence BER [%]	Impact of AirCell Presence BER [%]
-70	0.00	0.00	0.00
-71	0.01	0.01	0.00
-72	0.01	0.01	0.00
-73	0.02	0.02	0.00
-74	0.04	0.04	0.00
-75	0.08	0.08	0.00
-76	0.16	0.16	0.00
-77	0.32	0.32	0.00
-78	0.65	0.65	0.00
-79	1.30	1.30	0.00
-80	2.59	2.59	0.00
-81	3.63	3.63	0.00
-82	2.88	2.88	0.00
-83	2.40	2.40	0.00
-84	1.67	1.67	0.00
-85	1.77	1.77	0.00
-86	1.59	1.59	0.00
-87	1.82	1.82	0.00
-88	2.29	2.29	0.00
-89	3.41	3.41	0.00
-90	4.70	4.70	0.00
-91	5.47	5.47	0.00
-92	7.89	7.89	0.00
-93	9.08	9.08	0.00
-94	10.15	10.15	0.00
-95	11.93	11.93	0.00
-96	14.35	14.35	0.00
-97	17.63	17.63	0.00
-98	19.67	19.67	0.00
-99	22.79	22.79	0.00
-100	25.58	25.58	0.00
-101	29.15	29.15	0.00
-102	31.71	31.71	0.00
-103	34.89	34.89	0.00
-104	37.18	37.18	0.00
-105	41.26	41.26	0.00
-106	44.18	44.18	0.00
-107	45.77	45.77	0.00
-108	47.30	47.30	0.00
-109	49.64	49.64	0.00
-110	49.54	49.54	0.00
-111	49.57	49.57	0.00
-112	49.73	49.73	0.00
-113	50.00	50.00	0.00
-114	50.00	50.00	0.00

Appendix C - Spectrum Analyzer data collection

<u>Collection of TDMA signals</u>

As noted in section 4.2, both spectrum analyzers and site receivers were utilized for off-air data collection at Lena. The test equipment setup is shown in Figure 4.3. This section discusses the data collection performed with the spectrum analyzers, some findings, and results.

Briefly, it was found that the limitations of spectrum analyzers in capturing off-air TDMA signals were such that the data had very limited usefulness. The analyzers could not distinguish between timeslots, so they could *only* provide data when *exactly* 1 of the 3 timeslots on a channel was active. Thus, this data was used only for backup and confirmation that site receivers provided accurate data.

The spectrum analyzers were driven by the LabView software originally written for the 1997 flight test. This software configured the analyzers, read the captured data, and merged it into a single file with GPS timing information. The main collection screen for the LabView software is shown in Figure C.1.

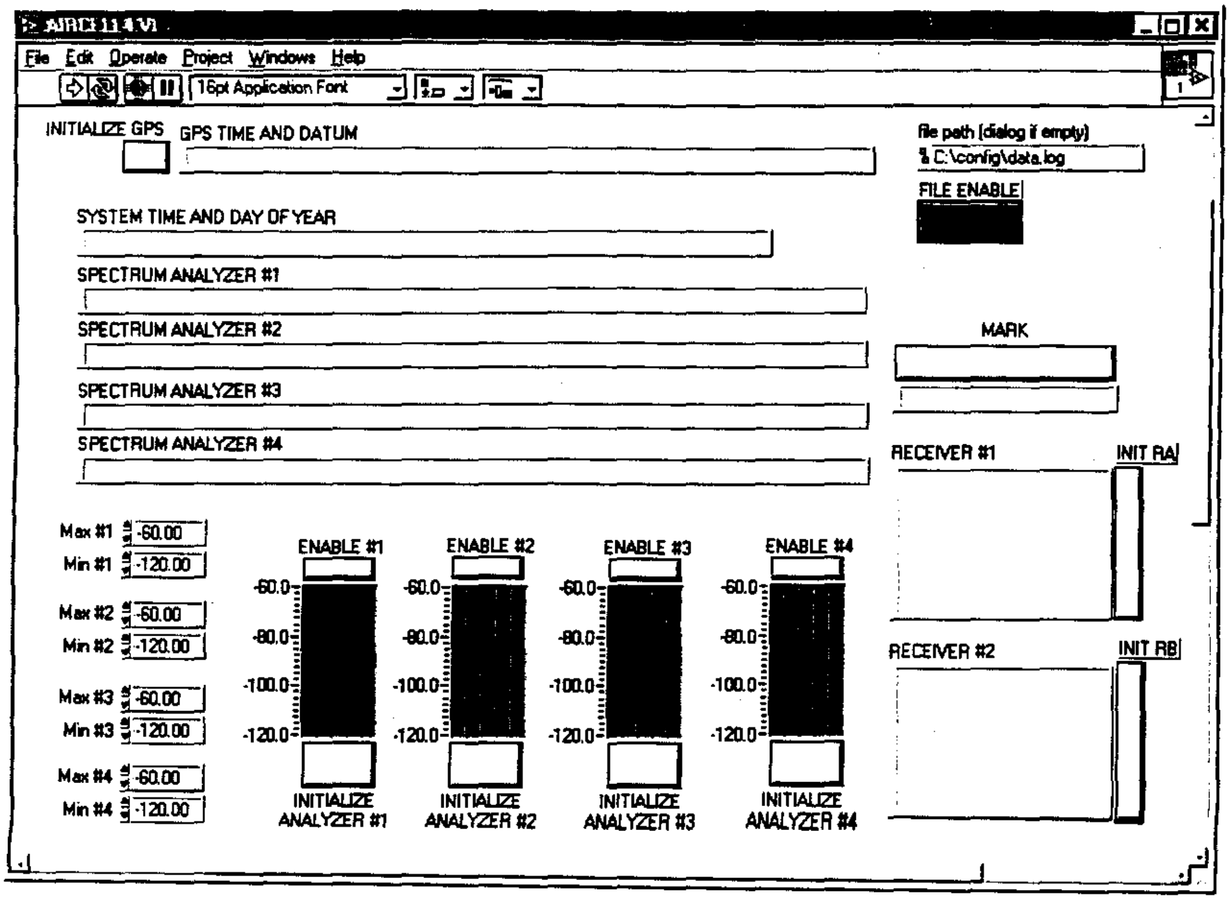


Figure C.1 - LabView Data Collection Software Main Screen

The spectrum analyzers were configured to a 0.8 second sweep time, a resolution bandwidth of 10 kHz, and a 150 kHz span. The sweep was centered on the TDMA channel of interest. The LabView software captured the maximum value in each 30 kHz channel, and logged that value. The sweep time was chosen so that several IS-136 reverse channel packets would contribute to each one second measurement, reducing the effect of momentary fading events. The 10 kHz resolution bandwidth yielded a minimal degradation in measurement accuracy (it is not perfectly matched to the bandwidth of the IS-136 signal, as discussed elsewhere in this report) while providing reduced noise floor (sensitivity) and better adjacent channel rejection than a 30 kHz resolution bandwidth.

Taking data for adjacent channels makes it possible (in post processing) to evaluate the 1st and 2nd adjacent channels, and determine whether the center channel measurement might have been degraded by the presence of adjacent channel activity. Suspect data points can then be discarded. Suspect data points are those in which adjacent channel energy is higher than the energy in the channel of interest by more than a threshold value.

It's *critically important to note* that in order to utilize spectrum analyzers to collect TDMA signals with accuracy, the reverse channel must contain *only* one signal of interest. *The other two timeslots must not be in use, or the strongest of the TDMA signals will be measured on any given sweep.*

This is a significant limitation on the use of spectrum analyzers for data collection. It is far better to have a collection method that synchronizes to the timeslots of the TDMA waveform. The site receivers do this – They must, or they couldn't function. Prior to arriving on-site, it was not known whether the site receivers could provide second-by-second RSSI data, or if that data would be accurate. Indeed, attempts to usefully characterize the Madill (observer site) radios during the 1997 test failed – the radios were both nonlinear and unreliable at low signal levels.

This test had greater success. After arrival at the site, information was obtained regarding site radio diagnostic commands. It was determined that by using a simple adapter cable, any RS-232 terminal could query Nortel Dual Mode radios for RSSI, and the radio would reply with the RSSI readings *for each of the three timeslots, along with information showing which timeslots were in use at that instant.*

As a result, WSE wrote a computer program that would query a pair of site radios once every second for RSSI (and timeslot activity) and log this data in a file along with GPS time obtained via a third serial port. (Lena was equipped with only two TDMA channels, so this enabled logging of *all* TDMA activity at the site.) This software was tested and found not to interfere with normal call processing activity. It was utilized simultaneously with spectrum analyzer data collection. This provided redundant reverse channel signal strength data... provided the signal was on the channel monitored by the spectrum analyzers, and only one timeslot was active on that channel at the time.

At Lena, channel 1008 is the digital control channel. Its forward channel is always keyed at the cell site. Reverse channel activity on this channel could not be monitored using spectrum analyzers *only*, as one analyzer is usually used to monitor the forward channel. The observation of forward channel transmission provides a flag to indicate a call in progress. If there is a forward channel signal, at least one call is present on the channel A call would *always* appear to be in progress on channel 1008, based on the forward channel 'flag'... Thus, spectrum analyzers alone could not monitor channel 1008.

Channel 6 could be set up to allow traffic monitoring by spectrum analyzers, by offlining two of the three digital timeslots – limiting it to serving a single caller. Unfortunately, Nortel configured its system to fill the two voice timeslots available on the control channel *first,* before it would key channel 6. Thus, channel 6 showed almost no activity, except during peak traffic periods.

Thus, the choice was clear... Use the TRU RSSI as the primary instrumentation for reverse channel collection, and relegate the spectrum analyzers to a cross-checking role.

The spectrum analyzers yielded the calibration data shown in Table C.1 and Table C.2. (This data was gathered simultaneously with that shown in Table 4.2 and Table 4.3 for the receivers, using the procedure described above.) As expected, the combination of prefiltering and preamplifiers lowered the noise figure and produced enhanced sensitivity comparable with that of the site receivers without introducing intermodulation products from out-of-band signals.

Table C.1 Spectrum Analyzer Calibration Results

	Channel 6	Channel 6	Channel 1008	Channel 1008
	Path A	Path B	Path A	Path B
Level at Multicoupler Input (dBm)	Analyzer A	Analyzer B	Analyzer A	Analyzer B
-60	-59.51	-59.25	-59.7	-59.4
-70	-69.6	-69.4	-69.84	-69.45
-80	-79.7	-79.44	-79.9	-79.58
-90	-89.7	-89.38	-89.96	-89.63
-100	-99.5	-99.04	-100.05	-99.6
-110	-109.6	-109.4	-109.8	-109.4
-120	-119.6	-118.4	-119.79	-119.3
-130	-128.3	-126.9	-127.9	-128.3

Table C.2 Spectrum Analyzer Deviation

	Channel 6	Channel 6	Channel 1008	Channel 1008
	Path A	Path B	Path A	Path B
Level at Multicoupler Input (dBm)	Analyzer A	Analyzer B	Analyzer A	Analyzer B
-60	0.49	0.75	0.3	0.6
-70	0.4	0.6	0.16	0.55
-80	0.3	0.56	0.1	0.42
-90	0.3	0.62	0.04	0.37
-100	0.5	0.96	-0.05	0.4
-110	0.4	0.6	0.2	0.6
-120	0.4	1.6	0.21	0.7
-130	1.7	3.1	2.1	1.7
Average of > -130 dBm values	0.40	0.81	0.14	0.52

Referencing and linearity of Spectrum Analyzer data

The analyzers were set to sweep a 150 kHz span in 800mS. Thus, they spent 160mS sweeping through a 30kHz cellular channel. In that 160 mS, the reverse channel TDMA transmitter sends 8 discrete burst transmissions. A spectrum analyzer will display 8 'spikes,' whose peaks roughly fit the envelope of a steady-state transmission having the same modulation, as shown in Figure C.2. (This figure uses a 3 kHz resolution bandwidth and 5 dB/div vertical scaling for greater clarity.) Since the spectrum analyzer sweeps could not be easily synchronized to the TDMA waveform frame rate, these 'spikes' move around a bit in time (and displayed frequency) from sweep to sweep (always occupying only 1/3 of the modulation envelope). This sweep to sweep variation in the displayed position of the bursts prevents the use of the H-P trace averaging mode as was used at Madill in 1997 with AMPS, which is a continuous transmission.

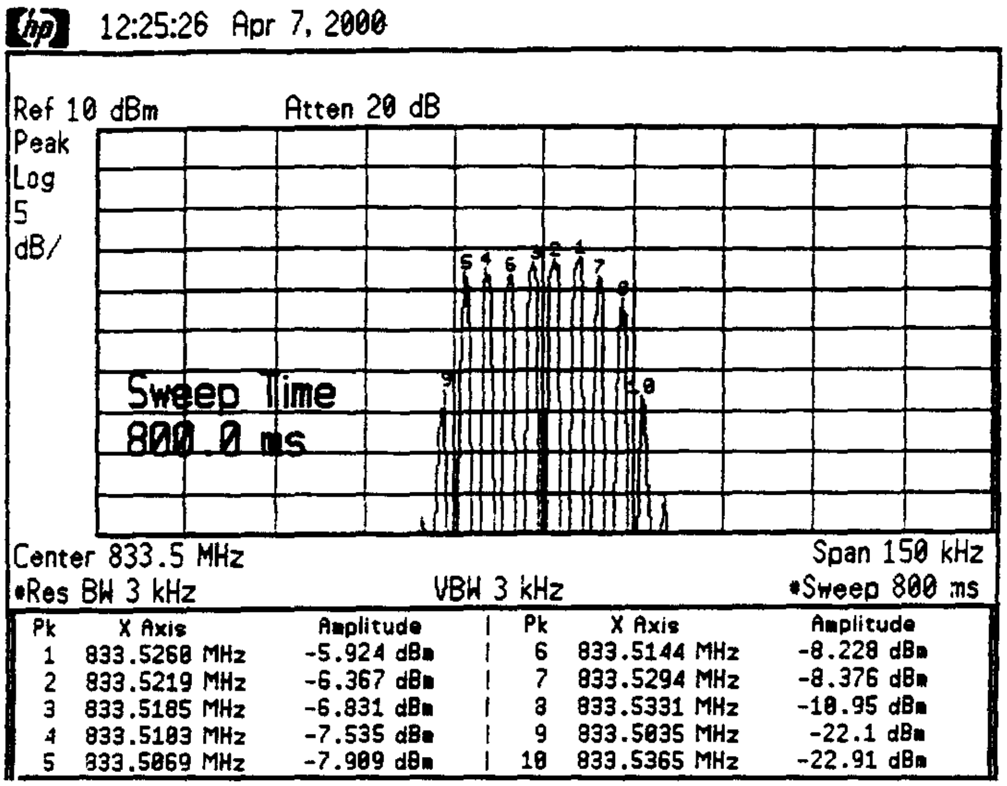


Figure C.2 Spectrum analyzer display of TDMA reverse channel waveform

The LabView software takes 'snapshots' from each spectrum analyzer sweep every 2 seconds. This snapshot is comprised of 400 data points describing the amplitude value at 400 equally spaced frequency points in the sweep. Of these 400 data points, 80 fall in a given 30 kHz cellular channel. The software picks the peak value of those 80 points and logs it to a file as a recorded sample.

Thus, the spectrum analyzer data really contains samples which represent the peak value among 8 sequential TDMA data frames, overlaid by the shape of the modulation envelope. Since the IS-136 modulation envelope does roll off a bit before reaching the edges of a cellular channel, it can be observed that typically only 6 of the 8 frames are in the 'flat' region of the channel, so only those 6 frames represent likely choices for a peak value during a sweep.

In other words, the spectrum analyzer records a peak reading from 6 sequential TDMA frames... *Not average power*. Thus one would expect the reading to be a bit 'hot' relative to the mean power in a fading environment... The question arises: how 'hot'? How large is the bias produced by this effect?

A look at the underlying probability theory will help to determine the offset:

It is commonly assumed that the power of the received signal level in a Rayleigh fading environment has an exponential distribution, that is:

$$f_P(s) = \frac{1}{\alpha}\exp\left(-\frac{s}{\alpha}\right),\ s \geq 0 \tag{1}$$

where α represents the average received power.

Let us define a random variable x that represents an 'instantaneous' (single TDMA frame) RSL power reading. Then, the value reported by the spectrum analyzer can be expressed as:

$$y = \max(x_1 \quad x_2 \quad \cdots \quad x_n) \tag{2}$$

where

- y - value reported by the spectrum analyzer
- x_i - individual instantaneous reading of the spectrum analyzer.

Assuming statistical independence of individual measurements, the cumulative distribution function for the RSL reported by the spectrum analyzer can be estimated as:

$$cdf_y(z) = P_r\{y < z\} = P_r\{x_1 < z\}P_r\{x_2 < z\}\cdots P_r\{x_n < z\} \tag{3}$$

or

$$cdf_y(z) = \prod_{i=1}^{n} cdf_x(z) = \left[1 - \exp\left(-\frac{z}{\alpha}\right)\right]^n \tag{4}$$

From (4), we can determine the probability density function for y as:

$$pdf_y(z) = \frac{d}{dz}cdf(z) = \frac{n}{\alpha}\exp\left(-\frac{z}{\alpha}\right)\left[1 - \exp\left(-\frac{z}{\alpha}\right)\right]^{n-1} \tag{5}$$

The expected value of y can be derived as:

$$E\{y\} = \int_0^{+\infty} z\, pdf(z)dz = \int_0^{+\infty} z\frac{n}{\alpha}\exp\left(-\frac{z}{\alpha}\right)\left[1 - \exp\left(-\frac{z}{\alpha}\right)\right]^{n-1} \tag{6}$$

or

$$E\{y\} = n\alpha\int_0^{+\infty} t\exp(-t)[1 - \exp(-t)]^{n-1}dt \tag{7}$$

where (7) is obtained after substitution $t = \frac{z}{\alpha}$.

The integral given in (7) can be solved numerically for different values of n and the results are presented in Figure C.3.

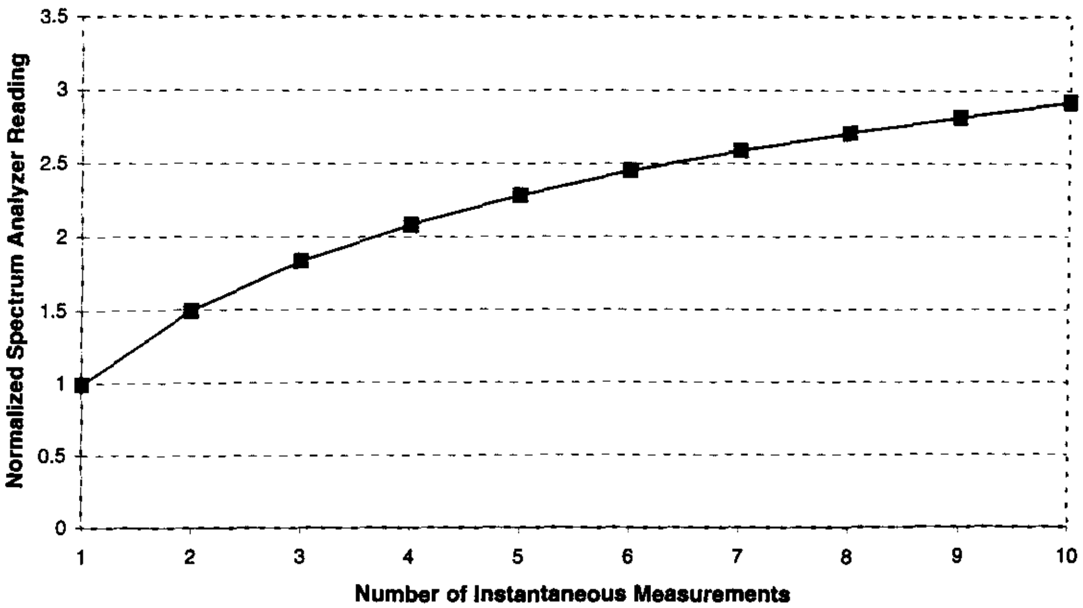


Figure C.3 Normalized effect of peak reading by the spectrum analyzer

In this particular case the, RSL of the spectrum analyzer is the maximum of six 'instantaneous' readings. From Figure C.3, that case corresponds to approximately 2.5 times (+4dB above) the mean signal reading.

Thus, the LabView (spectrum analyzer) data could be expected to read 4 dB higher than actual *if the samples are uncorrelated.* They're not. In 160 mS, there is some correlation, particularly between time-adjacent samples, and especially if the subscriber transmitter is stationary.

Observe that if the 6 values are perfectly correlated, the 6 'instantaneous' readings are by definition identical, the reported value will be equal to any/all of the values, and will equal the mean power. So, as sample correlation goes from 0 to 1, the reported value will go from 4 dB 'hot' relative to the mean, to a zero-offset reading.

The degree of sample correlation isn't precisely quantifiable - it varies with the mobility of the caller. Measurements from a stationary source should correlate almost perfectly, yielding an offset approaching 0dB, but high speed moving sources in vehicles can exhibit fast fading, low sample correlation, and an offset closer to 4dB. An engineering estimate is required. Based on practical measurement experience, the 1-3 dB range covers the most real-world cases, with a 3 dB offset being the *least favorable assumption* from the AirCell viewpoint. (The higher offset means a lower mean TDMA signal level - hence greater TDMA vulnerability to interference.)
Based on this reasoning, a 3 dB offset was assumed.

In addition, the calibration data for the spectrum analyzers using the HP8656B as an amplitude reference indicated that the spectrum analyzer read slightly 'hot' in the static case, after mathematically compensating for measured path gains/losses. Calibrated over the applicable amplitude range, good linearity was obtained at points more than about 10 dB above the thermal noise floor, at an essentially constant offset averaging 0.5 dB. This was offset was added to the offset obtained from path gain/loss measurements.

A third mechanism contributes a data offset for the spectrum analyzers. A resolution bandwidth of 10 kHz was chosen for data collection. This is less than the actual spectral occupancy of the reverse channel IS-136 signal. Thus, a portion of the signal energy is discarded, which will tend to drive down the observed value. This bandwidth was chosen because of a spectrum analyzer shortcoming relative to the site receivers – Spectrum analyzers use elliptical filters in their IF passband, which are not designed for a sharp cutoff. As a result, they exhibit far more adjacent channel sensitivity than a site receiver of equivalent noise bandwidth.

The adjacent channel rejection with a 30 kHz resolution bandwidth was judged to be unacceptable. A 10kHz bandwidth was chosen to both increase the rejection and lower the noise floor. A side note is that the IS-136 reverse channel spectrum is relatively flat over much of the 30 kHz channel, so it was possible to take several samples (frames) of essentially matching amplitude data with the 10 kHz filter during an 800 mS sweep, from which the peak was chosen. This 10 kHz resolution bandwidth also matches the testing implementation used in Texas during the July, 1997 test, so this consistency makes data comparisons between the tests more convenient to reference.

What is the value of this observation bandwidth offset? Assuming that a 30 kHz resolution bandwidth measurement will accurately reflect the power of an IS-136 carrier occupying most of a 30 kHz channel, one would expect a 'brickwall' (ideal bandpass) 10 kHz filter to read about 1/3 of the total power, or –4.77 dB relative to the total power. This isn't quite the case. The IS-136 signal is designed to occupy slightly less than 30 kHz, to allow for frequency inaccuracies, filter rolloff, and other implementation limitations. Further, the spectrum analyzer elliptical filters aren't 'matched filtering' for this waveform, nor are they a 'brickwall'. As a result, the 10 kHz resolution bandwidth chosen introduces a smaller measurement offset, determined by actual measurement to be –2 dB relative to the value observed with a 30 kHz measurement resolution bandwidth.

<u>This leads us the conclusion that the Spectrum Analyzers should read an aggregate of:</u>
+3 (Peak reading offset) +0.5 (calibration) –2 (filter bandwidth adjustment) dB or about 1.5 dB 'hot' … 1.5 dB higher than the actual mean power in a fading environment, referenced to the input of the site receive multicoupler.

<u>To compensate, 1.5 dB must be subtracted from the raw off-air Spectrum analyzer data.</u>